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TESTS OF SELECTIONS FROM HYBRIDS AND COMMERCIAL VARIETIES OF OATS.

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INTRODUCTION.

The breeding of oats was begun by the Bureau of Plant Industry in 1902. In that year Mr. Jesse B. Norton, then of the Plant-Breeding Laboratory, grew a collection of varieties at the Arlington Experimental Farm, near Washington, D. C., and made a large number of crosses. The resulting seed was planted in the spring of 1903 at Willey, Ill. The following year the work was transferred to the vicinity of Bloomington, Ill., where it was conducted from 1904 to 1908.[3] Field-plat tests of a number of commercial varieties were also made at Willey in 1903 and during the earlier years of the work near Bloomington. The experiments were confined to nursery tests in 1907 and 1908. Pure-line selections were made from these plats of commercial varieties, and material for crossing was also taken from them. The first selections were made from the hybrids in 1904, and reselections were made from time to time as further breaking up was apparent. All these selections were first grown in head rows, and those which appeared to be most desirable were grown in succeeding years in nursery rows of uniform length for comparative tests.

In 1907 considerable numbers of the selections were sent to the Kentucky, Iowa, and Cornell University (New York) agricultural

[1] This bulletin is intended for the use of farmers, agronomists, and cereal breeders, to whom the comparative data on selections from hybrids and commercial varieties should be of interest. It is adapted to the northern part of the United States as far west as the Missouri River.

[2] The work in cooperation with the Iowa Agricultural Experiment Station has been under the direct charge of Mr. L. C. Burnett, while that in cooperation with the Cornell University Agricultural Experiment Station has been under the direction of Dr. H. H. Love. The results of the work at these stations have been prepared for publication by Messrs. Burnett and Love, respectively. The remainder of the bulletin has been prepared by Mr. C. W. Warburton.

[3] Mr. Norton and the writer desire to acknowledge their indebtedness to Messrs. Deane N. and J. F. Funk for facilities furnished and for their hearty cooperation in the work near Bloomington.

experiment stations for testing. In that year, on the resignation of Mr. Norton from the United States Department of Agriculture to accept a position in Cornell University, the writer was placed in charge of the oat-breeding experiments in connection with his other work with oats in the Office of Cereal Investigations. In 1909, the work in Illinois having been discontinued, the Iowa station was made the headquarters for the testing of the oat selections. Since that time the more extensive tests have been made at the Iowa and Cornell University experiment stations, while smaller numbers of the selections have been tested at several of the other State stations, as detailed in the pages which follow.

It is the purpose of this bulletin to present the results of these preliminary tests, as indicative of the varieties and varietal combinations which are most likely to prove of value in the various sections where the tests have been conducted.

PARENTAGE OF THE SELECTIONS.

Three lots of hybrids were made by Mr. Norton, the first at the Arlington Experimental Farm in 1902, the second on the Funk brothers' farms at McLean, Ill., in 1905, and the third at the latter place in 1906. The hybrids resulting from the first lot of crosses have been quite widely tested. Those of the second and third lots have been grown only at the Iowa station and have not yet been tested long enough to report results. A considerable number of combinations were made in each of the years, but only those which are represented in the nursery tests reported in this bulletin are given here.

HYBRIDS.

Of the 52 varietal crosses made in 1902 only 19 are represented in the records after 1906, the others either having failed or having been discarded because of evident inferiority. The varietal combinations which are still represented in the nursery tests, with the series numbers by which they are designated, are as follows:

3. Golden Giant × Asia Minor Rustproof.
8. Danish Island × Asia Minor Rustproof.
25. European Hull-less × Garton Tartar King.
27. Garton Tartar King × Clydesdale.
28. Silvermine × Danish Island.
30. Burt × Clydesdale.
31. Burt × Red Rustproof.
32. Burt × Early Champion.
33. Burt × Burt.
34. Burt × Sixty-Day.
38. Burt × Clydesdale.
41. Asia Minor Rustproof × Clydesdale.
42. Asia Minor Rustproof × Clydesdale.
44. Asia Minor Rustproof × Garton Tartar King.
45. Asia Minor Rustproof × Silvermine.
48. North Finnish Black × Burt.
49. Sixty-Day × Clydesdale.
50. Sixty-Day × Probsteier.
51. Sixty-Day × European Hull-less.

COMMERCIAL VARIETIES.

In 1904 pure strains from commercial varieties were started from heads selected from the field plats grown that year in cooperation with the Funk Bros. Seed Co., at Shirley, Ill. The series numbers of these pure-line selections are as follows:

62. Sixty-Day.
63. Burt.
115. Red Rustproof.
117. Early Champion (Alaska).
118. Silvermine (Musselshell).
119. Probsteier.
120. Silvermine (Great Dakota).
123. Welcome.
124. Silvermine.
125. Silvermine (Great American).
131. Pringle Progress.
132. Sixty-Day.
137. Early Champion.
138. Early Champion.
142. Goldmine.
165. Sixty-Day.
5938. Sixty-Day.

THE SYSTEM OF NUMBERING.

As shown in the preceding paragraphs, each combination of varieties which was made was given a series number. Thus, all hybrids in which Sixty-Day, S. P. I. No. 5938, was the female parent and Clydesdale, P. B. No. 8, was the male parent were of series 49. Each combination of individuals was designated by a letter, as a, b, c, etc. For instance, if crosses were made on three plants of Sixty-Day oats, using the same or different plants of Clydesdale as the male parents, these individual combinations were numbered 49a, 49b, and 49c. Each plant produced in the F_1 generation was numbered consecutively for each combination of individuals, as 49a1, 49a2, 49a3, 49b1, etc. This number is always written as a unit. As individual plant selections were made, these were given serial numbers, this number being separated from the hybrid plant number by a dash. As subsequent selections were made, these were also numbered serially. Thus, 49a2–20–7 is pure-line selection No. 7 from pure-line selection No. 20 from plant No. 2 of the hybrid combination No. 49a, Sixty-Day × Clydesdale. If a reselection was made after a lapse of one or more years without selection, this lapse is indicated by xx, as 49a2–20–xx–7. If a bulk selection was made, the selection number is written in Roman instead of in Arabic, as 51a1–15–I.

The selections from commercial varieties were numbered in the same manner as those from the hybrids. Each stock was given a series number, but the numbers of pure-line selections from commercial varieties do not contain a letter followed by a numeral, as is the case in all hybrid numbers. Each individual selection bears the series number followed by a serial number within the series and separated from it by a dash, as 125–17. Bulk selections, as in the hybrids, are indicated by Roman numerals. Thus, 62–II–18–1 is the progeny of plant No. 1, selected from the progeny of plant No. 18, which in turn was selected from Bulk Selection II from the original

Sixty-Day stock. By this system of numbering, the common parentage of strains is shown at a glance.

MAKING THE SELECTIONS.

In both the hybrids and commercial varieties selections of individual heads were made, the selections being based on size of head, vigor of plant, size and color of grain, and other characters, as desired. The seed from each head was planted in a head row, usually a row 5 feet long. These rows were then numbered serially, to indicate their location in the nursery, while the selection number indicated the parentage of the selection. Only those rows which appeared to be of value were harvested. Usually not more than 10 per cent of the head selections which are made are retained after the first year's test in head rows. No doubt some valuable strains are lost in this way, but the success of work of this kind depends very largely on the judgment of the breeder. Where space and funds are more or less limited it appears to be better to make a large number of head or plant selections, cull these carefully in the head rows, and put only those that appear to be best in the comparative-yield test, going back to the original stock or drawing on new sources for additional material for head rows as opportunity offers rather than to select a comparatively small number of individuals and retain all these in the test for several years. It is only by handling large numbers of individuals and by culling very carefully that one can hope to gain the desired ends in cereal breeding.

The strains which were selected from the head rows were tested first at McLean, Ill., on the farm of Mr. Deane M. Funk. Later, considerable numbers of them were tested at the Iowa and Cornell University stations, and less inclusive tests were made at a number of other experiment stations. The results of these tests are given in the following pages.

TESTS AT M'LEAN.

METHOD OF TESTING.

The tests at McLean, Ill., were made in rod rows according to a method devised by Mr. Norton.[1] Briefly, the strains included in the comparative test at McLean were planted in rows 17 feet long and 1 foot apart, with every twentieth row as a check row. A pure-line selection of Sixty-Day, 62–II–19, was used as a check in 1907; a selection of this strain, 62–II–19–3, was used in 1908. The rows were 17 feet long, so that each row occupied 17/43560 or approximately 1/2560 of an acre.[2] As there are 512 ounces in a bushel of

[1] Norton, J. B. Notes on breeding oats. American Breeders' Association, Report 3, pp. 280–285, 1907. The method is described somewhat more in detail by H. J. Webber in Plant-breeding for farmers (New York, Cornell Agricultural Experiment Station, Bulletin 251, pp. 318–319, 1908) and by C. W. Warburton in Improvement of the oat crop (U. S. Department of Agriculture, Bureau of Plant Industry, Circular 30, pp. 6–8, 1909).

[2] The first fraction is equal to 0.00039027 acre, while the second is 0.00039063 acre.

oats, a yield of 1 ounce from one of these rows is at the rate of 5 bushels to the acre. Similarly, the rate of seeding is easily calculated; at the rate commonly in use in the corn belt, 2.5 bushels to the acre, one-half ounce of seed is required for each row.

RESULTS OF THE TESTS.

The tests at McLean in 1907 included 419 selections from hybrids and 82 pure-line selections from commercial varieties. In 1908, 378 hybrids and 69 pure-line selections were grown. Only 177 of the selections from hybrids and 51 of those from commercial varieties were grown both years. Table I summarizes the tests of these two years, the strains being grouped and averaged according to their parentage. This table shows the number of strains of each series which were grown each year and the number which were included in both years' tests, with the average yields in bushels to the acre.

TABLE I.—*Average yield per acre of each series of hybrids and commercial varieties of oats grown in nursery tests at McLean, Ill., in 1907 and 1908, showing also the number of strains of each series grown.*

Series.	Grown in 1907.		Grown in 1908.		Grown both years.	
	Number of strains.	Average yield.	Number of strains.	Average yield.	Number of strains.	Average yield.
		Bushels.		*Bushels.*		*Bushels.*
No. 3	5	43.96	3	32.70	3	38.00
No. 8	21	49.47	18	40.77	10	48.62
No 25			2	15.48		
No. 26	2	26.00				
No. 27	5	34.47	9	33.11	2	36.37
No. 28	1	35.80	1	31.55	1	33.67
No. 30	63	44.32	36	36.04	20	44.65
No. 31	5	38.27	8	40.09	2	44.58
No. 32	2	46.32	2	39.90	2	43.11
No. 33	29	48.58	10	43.16	10	47.67
No. 34	59	49.82	28	43.08	16	47.74
No. 35	1	33.75				
No. 38	7	43.59	4	33.21	4	38.57
No. 41	3	32.20	3	37.62		
No. 42	12	39.69	3	39.63	2	41.13
No. 44	4	37.09	4	33.46	1	35.77
No. 45	5	38.11				
No. 48	7	37.65	15	46.08	3	45.12
No. 49	135	46.14	177	38.07	71	45.14
No. 50	47	50.87	42	39.42	26	46.82
No. 51	6	40.10	13	26.33	4	37.34
No. 62	16	59.41	17	44.23	13	52.90
No. 63	6	56.55	5	48.43	5	52.83
No. 115	1	45.60				
No. 117	4	48.65	3	25.58	3	36.18
No. 118	3	37.55	1	28.15	1	34.15
No. 119	4	38.32	1	29.55	1	32.27
No. 120	4	38.95				
No. 123	1	42.95	1	32.25	1	37.60
No. 124	2	41.70	2	25.25	2	33.47
No. 125	13	38.66	8	33.66	8	35.72
No. 131	7	49.20	7	40.74	5	47.30
No. 132	3	61.72	8	46.42	3	56.11
No. 137	9	47.19	4	26.50	2	39.15
No. 138	6	49.35	4	26.42	4	38.50
No. 142	1	51.25	1	21.50	1	36.37
No. 165	1	56.40	1	36.85	1	46.52
No. 5938	1	46.30	1	28.45	1	37.37
Burt			5	41.65		
Total	501		447		228	
Average		46.42		38.25		45.04

THE MOST PROMISING SELECTIONS.

The highest yielding selections were all from commercial varieties, as follows: 62–II–19–3 from Sixty-Day, 58.27 bushels to the acre; 63–I–4 from Burt, 57.7 bushels; 62–II–6–3 from Sixty-Day, 57.37 bushels; 132–3–1 from Sixty-Day, 57.2 bushels; and 62–II–19–1 and 132–2 from Sixty-Day, 56.57 bushels. Practically all of the 25 highest yielding strains in these tests were derived from the Sixty-Day or Burt or a combination of these two varieties. Of the selections grown in both 1907 and 1908, 17 pure lines of Sixty-Day averaged 52.55 bushels, 15 strains of Burt averaged 49.39 bushels, and 16 strains of series 34 averaged 47.74 bushels. These yields were in excess of those of all other series except series 8, Danish Island × Asia Minor Rustproof, 10 strains of which averaged 48.62 bushels. The 25 strains which produced the highest average yields for the two years are shown in Table II.

TABLE II.—*Average yield per acre of 25 highest yielding oat selections grown in nursery tests at McLean, Ill., in 1907 and 1908.*

Rank.	Selection No.	Parentage.	Average yield.	Rank.	Selection No.	Parentage.	Average yield.
			Bushels.				*Bushels.*
1	62–II–19–3.	Sixty-Day	58.27	15	132–3–2.	Sixty-Day	54.55
2	63–I–4.	Burt	57.70	16	30a2–6–15.	Burt × Clydesdale.	54.35
3	62–II–6–3.	Sixty-Day	57.37	17	62–II–19.	Sixty-Day	53.95
4	132–3–1.	do	57.20	18	49a2–13.	Sixty - Day × Clydesdale.	53.72
5	62–II–19–1.	do	56.57				
5	132–2.	do	56.57	19	8a2–6–5.	Danish Island × Asia Minor Rustproof.	53.25
7	34a1–12–3.	Burt × Sixty-Day.	56.50				
8	8a2–6–6.	Danish Island × Asia Minor Rustproof.	56.35	20	50a1–15–5.	Sixty-Day × Probsteier.	53.15
9	63–I–1.	Burt	56.05	21	62–II–18–1.	Sixty-Day	53.12
10	49a1–7.	Sixty - Day × Clydesdale.	55.97	22	50a1–20–7.	Sixty-Day × Probsteier.	53.10
11	49a1–12.	do	55.57	23	63–I–7.	Burt	53.00
12	62–II–17–1.	Sixty-Day	55.37	24	49a2–18.	Sixty - Day × Clydesdale.	52.95
13	34a1–13–1.	Burt × Sixty-Day.	54.82				
14	8a2–6–4.	Danish Island × Asia Minor Rustproof.	54.60	25	62–II–6–1–1	Sixty-Day	52.80

Five of the 10 strains which produced the highest yields for the two years were pure-line selections of Sixty-Day, 2 were pure-line selections of Burt, 1 was a selection from a hybrid of these two varieties, 1 was a selection from a hybrid of Danish Island × Asia Minor Rustproof, and 1 was a selection from a hybrid of Sixty-Day × Clydesdale. Thus, of these 10 strains, 7 were pure lines from Sixty-Day or were selections from hybrids in which that variety was a parent, 3 were selections from Burt or from hybrids in which Burt was a parent, and only 1 was unrelated to either of these varieties. These 10 strains averaged 56.85 bushels to the acre, as compared with an average of 45.04 bushels for the 228 strains tested. The 25 highest yielding strains averaged 55.07 bushels to the acre. Of these 25 strains 15 were selections of Sixty-Day or

Burt or from a hybrid of these two varieties, 18 were pure lines of Sixty-Day or were selections from hybrids in which that variety was a parent, 6 were pure lines from Burt or selections from hybrids containing that variety, and only 3 represented neither variety. It is apparent, therefore, that Sixty-Day and Burt are valuable varieties for central Illinois, a conclusion which is in agreement with varietal tests at the Illinois experiment station.

COMPARISON OF SELECTIONS FROM HYBRIDS AND COMMERCIAL VARIETIES.

In 1907, 82 selections from commercial varieties exceeded 419 selections from hybrids in average yield to the acre by 2.57 bushels, or 5.59 per cent. In 1908, 69 selections from commercial varieties averaged 0.07 bushel, or 0.18 per cent more than 378 selections from hybrids. In all the 948 tests made in the two years, 151 pure lines from commercial varieties averaged 1.56 bushels, or 2.69 per cent more than 797 selections from hybrids. Of the 228 strains which were tested both years, however, 51 pure lines from commercial varieties averaged 0.56 bushel, or 1.24 per cent, less than 177 selections of hybrid parentage. Of the 10 highest yielding strains, 7 were selections from commercial varieties and 3 were from hybrids, while of the 25 highest, 13 were from commercial varieties and 12 from hybrids. This slight superiority for the selections from commercial varieties over those from hybrids is probably due largely to the fact that a large proportion of the former were from two varieties particularly suitable to central Illinois, Sixty-Day and Burt, while one or both parents of many of the hybrids were varieties not so fully adapted to the conditions.

TESTS AT THE IOWA AGRICULTURAL EXPERIMENT STATION.

INTRODUCTION.

The cooperative investigations for the improvement of the oat crop by the Iowa Agricultural Experiment Station and the Bureau of Plant Industry were begun in 1903. In the earlier years of the cooperation a study was made of the general conditions and methods of production. In 1907, 66 of the better strains from the oat nursery at McLean, Ill., were secured for testing. When the work at McLean was discontinued in 1909, the strains retained from the earlier trials at that place, 381 in all, were added to the nursery at Ames, Iowa.

CONDITIONS OF THE TESTS.

The plats used in all nursery tests at the Iowa station have each been confined to an area of 30 square feet. Each selection is planted in duplicate in rows 15 feet long and 1 foot apart. These rows are the unit of the nursery. Each is maintained as a separate plat until thrashing time, when the duplicates are united and yields and other

data on the grain are taken from the combined product. Figure 1 shows the method of harvesting the selections, while figure 2 is a view of the oat nursery when the harvest was about completed.

The soil used in the nursery work has varied somewhat, but in general may be termed rolling prairie upland. In 1907, 1908, and 1911 the tests were made on a dark prairie-loam soil. In 1909, 1910, and 1912 the fields varied from dark prairie loam to a much lighter colored gravelly loam.

The preceding crop each season except 1910 and 1911 was corn. In 1910 the nursery followed the oat varietal plats, while in 1911 it followed barley. When the nursery has followed corn the stalks have been removed and the land plowed in the fall. When following small

FIG. 1.—Field of oats, showing the method of harvesting selections when grown in nursery rows.

grain, it has been necessary to plow in the summer and to cultivate, in order to germinate all volunteer grain before seeding time the following season.

The climatic conditions have been far from uniform during the period covered by the tests reported in this publication. The years 1907 and 1908 were very wet. In 1909 the yields of all the early and medium selections were reduced, because they were blown down by a severe wind and rain storm before the grain filled. The 1910 crop was grown almost entirely from moisture that fell before May 1. The 1911 crop was grown under abnormally dry conditions and was badly damaged by a hot wind about July 1. The 1912 crop was produced under the most favorable conditions of any of the six, with the exception that two windstorms lodged many of the selections.

THE HIGHEST YIELDING SELECTIONS.

Of the 64 selections which have been tested at the Iowa station for six years, the five with the highest average yield to the acre follow: Welcome selection 123–5, 48.5 bushels; selection 50a1–24 from the hybrid Sixty-Day × Probsteier, 47.8 bushels; and Sixty-Day selections 62–II–6–3, 47.2 bushels, and 62–II–19 and 62–II–19–1, 46.5 bushels each. Of the 10 highest yielding strains four are selections from Sixty-Day, two from Burt, two from a hybrid of two strains of Burt, one from Welcome, and one from the hybrid Sixty-Day × Probsteier. Only three of these 10 selections have been derived from hybrids. Eight of the 10 highest yielding selections are early in maturing, the average date of ripening for the six years being before July 15. The highest yield obtained in the 4-year test is

FIG. 2.—Oat nursery at the Iowa experiment station when harvesting was almost completed, showing the method of protecting the bundles from mixture and from injury.

that of selection 34a1–12–1–1 from the Burt × Sixty-Day hybrid, 72 bushels to the acre. This high average is due largely to the extremely high yield of this selection in 1912, 117 bushels, while other selections from the same hybrid which yielded as well in previous years ranged from 60 to 80 bushels. This selection is not yet fixed, as it still shows considerable variation in some characters. This may explain, in part at least, its high yield. It will be further selected in the future.

Six closely related selections from series 8, Danish Island × Asia Minor Rustproof, ranged from 59 to 64 bushels in average yield. The highest yield obtained from any selection from a commercial variety in this test was 58 bushels from the Welcome selection, 123–5. Of the 25 selections which averaged 54 bushels or more in yield for

the four years, 7 are from series 34, Burt × Sixty-Day; 9 are from series 8, Danish Island × Asia Minor Rustproof; 4 from series 33, Burt × Burt; and 1 each from series 3, Golden Giant × Asia Minor Rustproof; series 49, Sixty-Day × Clydesdale; series 50, Sixty-Day × Probsteier; series 123, Welcome; and series 131, Pringle Progress.

AVERAGE YIELDS FOR THE VARIOUS SERIES.

The most valuable hybrid combinations included in the tests at the Iowa station are series 3, Golden Giant × Asia Minor Rustproof; series 8, Danish Island × Asia Minor Rustproof; series 31, Burt × Red Rustproof; series 33, Burt × Burt; series 34, Burt × Sixty-Day; and series 44, Asia Minor Rustproof × Garton Tartar King. Among the commercial varieties the highest average yields were produced by selections from series 63, Burt; series 123, Welcome; series 125, Silvermine; series 131, Pringle Progress; and series 165, Sixty-Day. The annual and average yields of each series for the four years are shown in Table III.

TABLE III.—*Annual and average yields of each series of oat selections grown at the Iowa station in a 4-year test, 1909 to 1912, inclusive.*

Series No.	Number of selections.	Yield (bushels per acre).				
		1909	1910	1911	1912	Average.
Hybrids:						
3	3	62.00	66.33	18.67	63.33	52.33
8	16	59.94	69.50	16.62	70.62	54.31
25	1	49.00	52.00	5.00	39.00	36.00
27	20	47.00	57.20	12.85	52.80	42.40
28	1	37.00	62.00	20.00	49.00	42.00
30	32	37.22	59.44	18.28	43.59	39.22
31	7	47.71	61.29	20.57	59.57	47.43
32	2	50.50	45.50	21.00	49.50	41.50
33	10	48.90	64.90	18.90	69.80	50.60
34	27	47.26	58.19	19.59	68.52	48.41
38	2	35.50	54.00	7.50	54.50	38.00
41	2	35.00	54.00	7.50	70.00	42.00
42	3	34.00	53.33	16.33	60.00	41.00
44	1	40.00	65.00	22.00	85.00	53.00
48	14	36.21	59.79	17.57	64.93	44.36
49	133	34.56	56.97	11.32	61.59	41.28
50	34	35.97	61.26	14.23	54.97	41.71
51	12	27.58	44.75	11.67	52.17	34.25
Total	320					
Average		39.06	58.13	14.25	59.43	42.72
Commercial varieties:						
62	17	40.29	52.41	22.12	64.12	44.88
63	6	41.33	69.50	18.67	62.00	48.00
117	3	36.33	59.33	13.00	46.67	38.67
118	1	40.00	69.00	14.00	52.00	44.00
123	1	51.00	90.00	24.00	65.00	58.00
124	1	41.00	77.00	21.00	45.00	46.00
125	6	44.00	70.50	16.50	45.50	44.17
131	6	40.33	64.00	24.50	61.67	47.67
132	8	40.37	69.50	20.50	45.12	44.00
137	2	41.50	58.50	19.50	42.50	40.50
138	2	45.00	54.00	21.00	48.50	42.00
165	2	43.00	67.00	24.50	62.00	50.00
5938	1	39.00	50.00	30.00	29.00	37.00
Burt	5	38.60	63.20	24.20	55.60	45.60
Total	61					
Average		40.89	62.46	20.90	55.43	44.92
SUMMARY.						
Hybrids	320	39.06	58.13	14.25	59.43	42.72
Commercial varieties	61	40.89	62.46	20.90	55.43	44.92
Total	381					
Average		39.36	59.04	15.31	58.79	43.12

When a comparison is made of all selections from hybrids with all selections from commercial varieties, it is found that the selections from commercial varieties exceed in average yield those from hybrids in three of the four years. The selections from commercial varieties were 1.83 bushels to the acre higher in average yield in 1909, 4.33 bushels higher in 1910, and 6.65 bushels higher in 1911, while the selections from hybrids exceeded in average yield those from commercial varieties by 4 bushels in 1912. The average yield of all selections from commercial varieties for the four years was 2.2 bushels to the acre higher than that of all selections from hybrids. This does not necessarily imply, however, that hybridization is not of value in improving oats or other cereals. In this particular case, most of the selections from commercial varieties were from Sixty-Day, Burt, and Silvermine, varieties which are well adapted to central Iowa conditions. On the other hand, a number of the varieties used in making the hybrids were not so suitable for Iowa; hence, selections from these hybrids could hardly be expected to yield well.

TESTS AT THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.[1]

INTRODUCTION.

A series of the selections made by Mr. Norton was furnished to the plant-breeding department of Cornell University at Ithaca, N. Y., in 1907. Field work was begun that year and has been conducted continuously since that date. The experiments have been conducted so long that the crops have been grown under a wide range of seasonal climatic conditions.

METHODS OF TESTING.

The tests have all been made in rows about 1 rod long, though the exact length of the row has varied from time to time. At present the rows are planted 16 feet in length and 1 foot apart. At the time of cutting, 6 inches are cut off each end of the row and discarded, leaving a 15-foot row on which to base the calculations. The ends of each row are cut off so that the effect of the increased nutrition at the ends will not enter into the calculations and affect the results. By using a 15-foot row and weighing the grain in grams the calculated yield in bushels per acre is obtained by multiplying the grams per row by 0.2 (grams per row $\times$ 0.2 = bushels per acre).[2] The seed required for each row is weighed into a separate envelope before planting time. All seeding is done by hand, and the rows are marked off by hand, using a board 1 foot wide. It has been

[1] The writer desires to acknowledge his indebtedness to Messrs. F. J. Pritchard, E. P. Humbert, and C. E. Leighty, who at various times have rendered valuable assistance in making these tests. Dr. Leighty also assisted in the preparation of the data for publication.

[2] The factor actually is 0.20006613+.

found that short rows can be sown by hand fairly rapidly, very uniformly, and much more accurately than by machine.

In the beginning of the work only one row of each strain was grown, but it was found that the same strain should be replicated in as many rows in different parts of the field as is feasible. Beginning in 1909, the different strains were replicated several times and have been each year since then. After trying different systems it has been decided to repeat each variety or strain 10 times, as any less number is considered too small. Since the average of all the rows is easily obtainable with 10 as a divisor, it makes it all the more desir-

FIG. 3.—Oat nursery at the Cornell University experiment station, 1912.

able to use this number. Figure 3 shows the oat nursery at the Cornell experiment station in 1912.

In regard to the use of short rows for the testing of strains, it may be said that of all the systems tried this method seems the most accurate. This is especially true on soil which is very nonuniform. It is not safe to draw conclusions from one plat of a variety, as the plat may be very favorably or unfavorably located and the results influenced thereby. On this point attention may be called to the work of Dr. T. L. Lyon.[1] After comparing the errors obtained from rod rows and tenth-acre plats, he concludes:

[1] Lyon, T. L. A comparison of the error in yields of wheat from plats and from single rows in multiple series. Proceedings, American Society of Agronomy, v. 2, 1910, p. 38–39, 1911.

The advantage from the small plats is not only in point of accuracy, but also in the area of land required. Seven one-tenth-acre plats covered an area of 30,492 square feet, while 70 of the 17-foot rows (10 rows of each variety) required only 1,190 square feet. The use of the row method in variety testing is commended by the results of this test.

When the crop is ripe and ready for cutting, each row is cut and tagged separately, as shown in figure 4. The rows are then shocked together under canvas to dry for thrashing. The thrashing is done by means of a machine constructed by Mr. H. W. Teeter, superintendent of field work in the plant-breeding department. This consists of a cylinder built into a box lined with galvanized iron. The

FIG. 4.—Harvesting the 15-foot rows of oats at the Cornell University experiment station.

box is so constructed that the top and back may be lifted up, allowing the grain and straw to shake down on a coarse screen placed over a receptacle which receives the grain, as shown in figure 5. The advantage of lifting the top is that a full view of the interior is possible, so that if any kernels remain behind they can be seen and brushed out. The cleaning is done by means of a small counter seed cleaner.

Since 1908 every tenth row has been used as a check. All the check rows are sown with the same kind of seed, so that a check on soil differences may be obtained. The same variety, selection 50a1–18–4 from the hybrid Sixty-Day × Probsteier, was used as a check from 1908 to 1911, inclusive, but in 1912 a new check, Canada

Cluster, was used. This is a standard variety for the State of New York. These check rows, however, were not used in computing the yields reported herein, which are the actual yields of the various strains.

SOIL CONDITIONS.

The tests have been made on a soil of the Dunkirk clay-loam type, except in 1908, when the planting was made on a gravelly loam. In 1910 a duplicate series of tests was also grown on the gravelly loam in order to see whether there was any difference in the results from the two types of soil. As the experiments have progressed, an effort has been made to make the conditions uniform. Ordinary

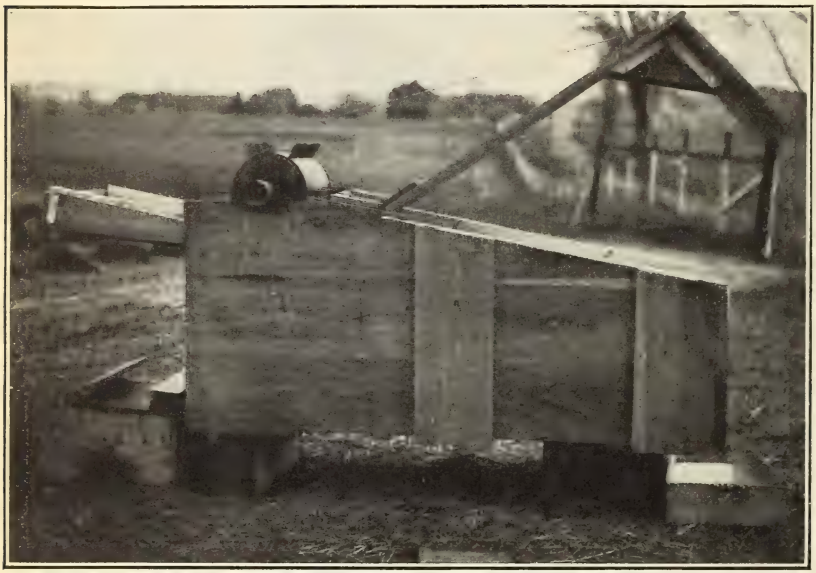

FIG. 5.—Side view of the machine used in thrashing rows of oats at the Cornell University experiment station.

cultural conditions were duplicated as nearly as possible; hence, only moderate applications of fertilizers were made.

YIELDS OF GRAIN FROM THE SELECTIONS.

The selections which produced the highest yields per acre in the 6-year test were 34a1–11–2 from the hybrid Sixty-Day × Burt, with an average yield of 61 bushels; selection 123–5 from the commercial variety Welcome, 60.5 bushels; selections 50a1–10 and 50a1–22 from the hybrid Sixty-Day × Probsteier, 60.4 and 58.2 bushels, respectively; and selection 62–II–18–1–1 from the commercial variety Sixty-Day, 57 bushels. Of the selections which exceeded 55 bushels in yield in the 6-year test, 4 were from series 34, Sixty-Day × Burt; 4 from series 49, Sixty-Day × Clydesdale; 2 from series 50, Sixty-Day × Prob-

steier; and 1 each from series 31, Burt × Red Rustproof; 62, Sixty-Day; 120, Silvermine; 123, Welcome; 125, Silvermine; and 5938, Sixty-Day.

In 1911 a comparatively small number of the selections was grown, but a large proportion of those which were dropped that year were again included in the tests in 1912. Of the selections which were grown in the five years, 1907, 1908, 1909, 1910, and 1912, 27 exceeded 55 bushels in average yield. Of these 27 selections, 10 were from series 49, 8 from series 34, 3 from series 50, and 1 each from series 31, 42, 62, 120, 123, and 5938.

COMPARISON OF SELECTIONS FROM HYBRIDS AND COMMERCIAL VARIETIES.

The average yield of all the selections from hybrids tested in 1907 was 50 bushels per acre, while the yield for all selections from commercial varieties was 49.4 bushels per acre. In 1908 the yield for all selections from hybrids was 55 bushels per acre, while that for all selections from commercial varieties was 49.3 bushels. In 1909 the average yields were 36.5 and 38.9 bushels, respectively; in 1910, 64.6 and 59.9 bushels; in 1911, 45.9 and 48.7 bushels; and in 1912, 52.5 and 51.1 bushels. The average for all the selections from hybrids tested for the years from 1907 to 1912, inclusive, was 51.3 bushels, while that for all selections from commercial varieties was 49.8 bushels. When the results are taken year by year it is seen that only in the years 1909 and 1911 were the yields of the selections from commercial varieties greater than the yields of the selections from hybrids.

The results, although indicating a higher yield for the selections from hybrids, do not show enough difference to warrant recommending hybridization over straight selection as a means of improvement. One advantage of the selections from commercial varieties is that it is possible to test a great many of them while one is purifying the hybrids from one cross. The purification of hybrids must be continued at least to the third generation before comparative tests can be made; meantime a great many selections could have been tested.

A somewhat different set of figures is obtained from the average yields of the different series as presented in Table IV. This table shows the annual and average yields of each series, without regard to the number of selections which were grown, for the years 1907, 1908, 1909, 1910, and 1912. The results for 1911 are not included, because several of the series were not grown that year. The averages for the selections from hybrids and from commercial varieties given in the summary are obtained from the yields of the different series, as shown in the table. For this reason they do not agree exactly with the averages in the preceding paragraph, where the individual selection, not the series, was the unit.

TABLE IV.—*Annual and average yields of the various series of oats grown at the Cornell University station in 1907, 1908, 1909, 1910, and 1912, with the 5-year average for each.*[1]

Series No.	Parentage.	Yield (bushels per acre).					
		1907	1908	1909	1910	1912	Average.
	SELECTIONS FROM HYBRIDS.						
3	Golden Giant×Asia Minor Rustproof	43.3	33.1	38.7	67.8	50.1	46.6
8	Danish Island×Asia Minor Rustproof	38.2	53.3	37.2	72.8	50.8	50.5
27	Garton Tartar King×Clydesdale	45.0	40.0	40.1	65.0	64.9	51.0
30	Burt×Clydesdale	56.2	49.3	36.2	65.0	50.8	51.5
31	Burt×Red Rustproof	42.4	78.7	42.3	65.6	45.8	55.0
32	Burt×Early Champion	42.5	62.5	42.8	64.7	47.2	52.0
33	Burt×Burt	37.4	62.4	33.1	79.7	55.0	53.5
34	Burt×Sixty-Day	44.7	66.3	36.7	65.9	44.5	51.6
38	Burt×Clydesdale	48.7	48.7	29.8	59.1	48.2	46.9
42	Asia Minor Rustproof×Clydesdale	45.9	60.0	36.2	62.3	55.0	51.9
49	Sixty-Day×Clydesdale	58.7	47.8	38.6	65.3	54.8	53.0
50	Sixty-Day×Probsteier	61.8	56.6	38.3	57.7	55.4	54.0
51	Sixty-Day×European Hull-less	51.2	37.5	29.6	51.2	48.6	43.6
	Average	47.4	53.5	36.7	64.8	51.6	50.8
	SELECTIONS FROM COMMERCIAL VARIETIES.						
62	Sixty-Day	57.7	62.8	41.9	56.9	48.3	53.5
63	Burt	44.7	57.5	39.9	65.2	47.3	50.9
115	Red Rustproof	42.5	30.0	36.3	53.4	62.6	44.9
117	Early Champion	51.2	18.7	29.6	47.1	41.9	37.7
118	Silvermine	51.2	47.5	39.9	51.4	82.8	54.6
120	do	57.5	42.5	48.3	62.7	67.3	55.7
123	Welcome	53.7	67.5	46.8	61.2	69.8	59.8
125	Silvermine	50.8	40.0	43.6	66.4	64.7	53.1
131	Pringle Progress	37.5	40.0	35.7	50.6	56.5	44.1
132	Sixty-Day	58.7	60.0	41.9	56.4	49.1	53.2
137	Early Champion	50.8	38.7	35.9	42.8	36.9	41.0
138	do	61.2	47.5	39.5	48.1	34.8	46.2
142	Goldmine	47.5	35.0	34.8	34.8	39.1	38.2
5938	Sixty-Day	60.0	55.0	56.9	57.5	55.2	56.9
	Average	51.8	45.9	40.8	53.9	54.0	49.3
	SUMMARY.						
	Average of selections:						
	From hybrids[2]	47.4	53.5	36.7	64.8	51.6	50.8
	From commercial varieties[2]	51.8	45.9	40.8	53.9	54.0	49.3

[1] The results for 1911 are not included, as some of the series were not grown that year.
[2] Averages based on the series as a unit.

Table IV gives some indication of the relative value at the Cornell station of the different hybrids and commercial varieties as stocks from which to make selections. The highest average yield for any series for the five years was that of series 31, Burt×Red Rustproof, 55 bushels, due largely to a very heavy yield in 1908. The next highest average yield, 54 bushels, was obtained from series 50, Sixty-Day×Probsteier, of which from 11 to 13 selections were grown each year, whereas only two selections from series 31 were grown. It is probable that series 50 is more valuable for New York than series 31; in fact, two selections from the former exceeded the best selections from the latter in average yield for the five years. Other valuable hybrid stocks, as indicated in Table IV, are series 33, Burt×Burt, and series 49, Sixty-Day×Clydesdale. Among the individual selections, some of the highest yielding ones are included in series 34,

Burt × Sixty-Day, but this series includes sufficient strains which are low in yield to bring its general average 2.4 bushels below that of series 50.

Of the commercial varieties, the highest averages for the five years are shown by series 123, Welcome, 59.8 bushels; 5938, Sixty-Day, 56.9 bushels; 120, Silvermine, 55.7 bushels; and 118, Silvermine, 54.6 bushels. Of the varieties included in this test it is probable that these three are the most valuable in the vicinity of the Cornell station.

PLACE VARIATION.

The variation in results and in the relative yields of the different strains from year to year has been considerable. This is well shown by the yields of the best 10 hybrids and selections for each year. In certain years the earlier strains represented by the Burt and Sixty-Day types are the best yielders, while in other years the later types represented by the Silvermine or Welcome yield best. This place variation operates to make 1-year varietal tests inconclusive. Unusual conditions affecting the results may arise in any season. For example, the growing seasons of 1909 and 1910 were both rather hot and dry at the time the oats were filling and ripening. Such conditions favor the Sixty-Day type, since it will withstand more hot, dry weather than the later sorts. The seasons of 1911 and 1912 were very different from those of 1909 and 1910. The early parts of these seasons were hot and dry, with the exception of early May, 1912. Most of the early-maturing selections ripened under adverse conditions, while the coming of rain and cooler weather gave an advantage to the later varieties. This is evidenced by the fact that the best yielding strains for 1909 and 1910 were early types, represented by the Sixty-Day series, while the best yielding strains for 1911 and 1912 were later types, represented by the Silvermine series.

COMPARISON OF THE BEST SELECTIONS WITH COMMERCIAL VARIETIES.

After the tests had been conducted for two years it seemed desirable to compare the yielding capacity of the different strains with some commercial varieties. A number of such varieties were brought into the test in 1909, but owing to lack of room only a few tests were made of each variety. More varieties have been added from time to time, so that at present most of the well-known commercial varieties are included. It was necessary to reduce the number of commercial varieties in 1911, but all of them were put back into the test for 1912.

Among the commercial varieties which were tested in 1909, 1910, and 1912, the highest average yield was obtained from the Lincoln variety, 65.1 bushels to the acre. This yield is 0.1 bushel higher than that of Welcome selection 123–5. In several larger tests conducted in different parts of the State during 1912, selection 123–5

outyielded the Lincoln variety. The two are very close together, however, and another year or two will possibly decide which one is better adapted to New York conditions.

When the average yield of the best eight selections for the three years is compared with the average yield of the eight unselected varieties, there is a marked difference in favor of the selections. The average yield of the eight selections is 61.5 bushels per acre, while that for the eight commercial varieties is 53.1 bushels per acre. The average for the eight new strains is higher than the yield of any one variety except the Lincoln. The average weight per bushel of the eight selections was 30.31 pounds, while that of the commercial varieties was 29.75 pounds.

TESTS AT VARIOUS OTHER EXPERIMENT STATIONS.

INTRODUCTION.

At various times from 1907 to 1910, seed of certain of the selections from hybrids and commercial varieties discussed in this bulletin was sent to a number of the State experiment stations. In addition to the data already reported from the Iowa and Cornell University stations, where the principal tests were conducted in cooperation with the Bureau of Plant Industry, valuable data have been obtained and are here reported from the Pennsylvania, Virginia, Ohio, Indiana, Kentucky, Tennessee, and Minnesota agricultural experiment stations. The results of tests at the Arlington Experimental Farm in Virginia are also included.

PENNSYLVANIA.[1]

Twenty selections which were believed to be adapted to the local conditions were sent to the Pennsylvania experiment station in 1910. These strains were tested on a Hagerstown clay-loam soil in a good state of fertility. In 1910 and 1911 the oats followed potatoes in a rotation of potatoes, oats, wheat, and clover and timothy; in 1912 they were grown in a similar rotation in which corn replaced the potatoes. In each of the first two years 160 pounds of acid phosphate to the acre were applied to the oats; in 1912, 320 pounds were used. The 20 strains were grown in 1910 in rows 60 feet long and 14⅔ inches apart, made by sowing from alternate holes in the grain drill. In 1911 and 1912, owing to lack of land, only the most promising strains were grown. The plats were 139 by 5.5 feet in 1911 and 150 by 5.5 feet in 1912. The rate of seeding was 9 pecks to the acre.

The only strain which exceeded the check variety Japan in yield for the three years was a selection of the Sixty-Day, 62–II–18–1–1,

[1] These tests were made by Profs. F. D. Gardner and C. F. Noll, to whom acknowledgments are due for the results here reported.

with an average yield of 60.4 bushels to the acre, 5.32 bushels more than was obtained from the Japan. The average yield of straw for the years 1911 and 1912, however, was nearly 700 pounds to the acre less than that of Japan. As the straw is a valuable part of the crop in Pennsylvania, this difference is worthy of consideration. Selections 49a1–25–4 (Sixty-Day × Clydesdale) and 132–3–1 (Sixty-Day) averaged 53.63 and 53.26 bushels to the acre, respectively. In 1911 and 1912, several commercial varieties were grown in the same field with these selections. The highest yields obtained were 66.8 bushels from Joanette and 58.4 bushels from Sixty-Day, as compared with 59.3 bushels from the Sixty-Day selection 62–II–18–1–1.

VIRGINIA.

ARLINGTON EXPERIMENTAL FARM.

Spring oats are not ordinarily grown in the vicinity of Washington, D. C., where the Arlington Experimental Farm is located, as climatic and soil conditions usually make early spring planting difficult, and early planting is essential to the successful production of the crop. On the other hand, fall-sown oats of certain varieties generally survive the winter and produce good yields, maturing before the earliest spring-sown varieties. As it is sometimes desirable, however, to sow oats in this section in the spring, preliminary tests of more than 200 of the selections were made in 1908. The plantings were made on March 27 in rows 17 feet long and 1 foot apart. Only one row of each strain was grown. The season was rather unfavorable to spring oats, the highest yield being at the rate of 30 bushels to the acre. The following year, 1909, no spring oats were grown. In 1910, 16 of the strains which appeared to be most promising in 1908 were planted in 17-foot rows on March 22. In 1911 and 1912 these strains were planted in plats measuring 1 square rod each. The tests which have been conducted are altogether too meager to furnish data from which conclusions may be drawn. Apparently the most favorable strains are the selections of Sixty-Day, the hybrids of Burt and Sixty-Day (series 34), and selection 49a1–12 from the hybrid of Sixty-Day and Clydesdale. The latter has produced the highest average yield.

VIRGINIA AGRICULTURAL EXPERIMENT STATION.[1]

In the spring of 1908, 47 strains of the hybrids and selections were sent to the Virginia experiment station at Blacksburg. The following year 46 additional strains were sent. The tests in 1908 and 1909 were made in rows 4 rods long and 1 foot apart, those of 1910 in

[1] These tests were made by Profs. Lyman Carrier and T. B. Hutcheson, to whom acknowledgments are due for the results here reported.

plats of 0.01 acre each and those of 1911 and 1912 in plats of 0.02 acre each. Figure 6 shows a portion of the nursery used in the 1908 test. Owing to lack of space, the number of strains under test was greatly reduced in 1911. Only those which appeared to be most promising, as indicated by the 1908 and 1910 tests,[1] were grown in the succeeding years.

Of the strains grown three or more years, the highest average yields to the acre were obtained from a pure line of the Sixty-Day oat, 62–II–6–3, 37.5 bushels; selection 34a1–32 from the hybrid Burt × Sixty-Day, 36.98 bushels; and a pure line of Silvermine, 125–3, 35.94 bushels. Of the commercial varieties grown at this station Silver-

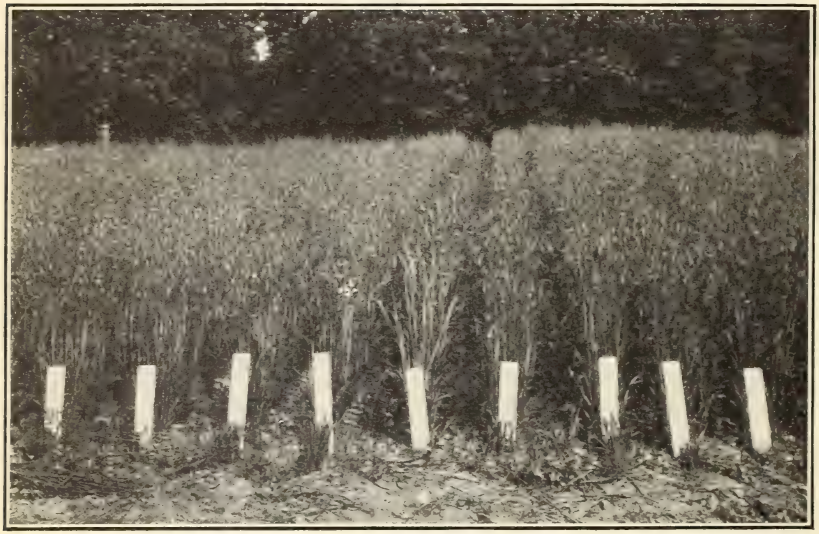

FIG. 6.—A portion of the oat nursery at the Virginia experiment station in 1908.

mine leads in yield. None of the three strains just mentioned was included in the 1908 tests. Of the nine strains which have been grown all four years (1908 and 1910 to 1912), the highest average yield, 32.9 bushels, was produced by selection 33a1–4–1 from a hybrid of two strains of Burt, though this yield only slightly exceeded those of selections 34a1–19–4 and 34a1–25–2 from the hybrid Burt × Sixty-Day. Apparently, among the varieties tested the most promising for use in producing new strains for southwestern Virginia are the Silvermine, Sixty-Day, and Burt. Late-maturing selections in series 8, 42, and 45 did not compare favorably with the earlier ones in series 33 and 34.

[1] The 1909 crop was partially destroyed by a storm just before harvest, and for that reason the results for that year have not been used.

OHIO.[1]

The tests at the Ohio Agricultural Experiment Station at Wooster have been quite extensive. Forty-seven of the selections were sent to Prof. C. G. Williams, agronomist, in 1908, and 62 were added to the tests the following year. These 109 selections represented the various series as follows: Series 8, 7 selections; series 27, 1; series 30, 5; series 31, 4; series 33, 8; series 34, 11; series 38, 1; series 42, 1; series 44, 1; series 48, 4; series 49, 27; series 50, 16; series 51, 3; series 62, 13; series 63, 3; series 132, 1; series 137, 2; and series 165, 1. The first test of these selections was made in duplicate in rows 17 feet long and 1 foot apart. Later tests of the more promising strains were made in hundredth-acre plats, a few of the best going finally into the regular varietal test in tenth-acre plats.

In 1908 four of the 10 highest yielding strains were of series 50, Sixty-Day × Probsteier, two were of series 49, Sixty-Day × Clydesdale, and two were of series 62, pure lines of Sixty-Day. The highest yield of all, however, 85.08 bushels to the acre, was obtained from 8c1–5–4, a selection from the hybrid Danish Island × Asia Minor Rustproof. Selections 50a1–24 and 50a1–15 from the hybrid Sixty-Day × Probsteier yielded 80.02 and 78.13 bushels, respectively. The highest yields obtained from pure lines developed at the Ohio station from three commercial varieties were as follows: Sixty-Day, 86.54 bushels; Siberian, 80.51 bushels; and Improved American, 81.2 bushels.

The highest acre yields produced by the selections from the Office of Cereal Investigations in 1909 were obtained from 50a1–15, 83.24 bushels; 50a1–21, 72.31 bushels; 50a1–24, 69.96 bushels; and 8c1–5–4, 69.96 bushels. The other six high-yielding strains from the 1908 tests yielded from 60 to 66 bushels each. The yield of 50a1–15, 83.24 bushels to the acre, was higher than that of any other variety tested in hundredth-acre plats in 1909.

In 1910 four strains from the Office of Cereal Investigations were grown in tenth-acre plats and 24 in hundredth-acre plats. The yields of the four strains in tenth-acre plats were as follows: 50a1–15, 63.64 bushels to the acre; 50a1–21, 56.25 bushels; 50a1–24, 74.11 bushels; and 8c1–5–4, 77.12 bushels. The only varieties from other sources which exceeded 8c1–5–4 in yield were Storm King, 79.3 bushels, and a selection from Siberian, 77.86 bushels. The average yields of the four strains just mentioned for the three years 1908, 1909, and 1910 were as follows: 8c1–5–4, 77.4 bushels; 50a1–15, 75 bushels; 50a1–24, 74.7 bushels; and 50a1–21, 67.6 bushels. Of the 24 strains grown in hundredth-acre plats in 1910 the best yields were produced by 34a1–11–2–1 and 34a1–11–2–3, 98.44 bushels to the acre each;

[1] These tests were made by Prof. C. G. Williams, to whom acknowledgments are due for the results here reported.

34a1–12–3, 88.28 bushels; 49a1–25–4, 87 bushels; 34a1–11–2–6, 86.72 bushels; 34a1–11–2–4, 85.94 bushels; and 34a1–12–1–1, 83.59 bushels.

The tests in 1911 and 1912 included only five of the strains, one of series 49 and four of series 34, the four strains which were grown on tenth-acre plats in 1910 having been lost. The highest average yields for the two years were produced by selections 34a1–11–2–3 and 34a1–11–2–6, 72.72 and 72.45 bushels to the acre, respectively, as compared with 75.38 bushels from a selection of Improved American made at the Ohio station and 75.18 bushels from a commercial lot of Silvermine. It is unfortunate that the strains of series 8 and 50, which were so promising in the earlier tests, were necessarily discontinued, as it is believed that they would have equaled or exceeded in yield those of series 34 and 49. From such evidence as is available the hybrids among those tested which appear to be of greatest value for Ohio are Danish Island × Asia Minor Rustproof, Burt × Sixty-Day, Sixty-Day × Clydesdale, and Sixty-Day × Probsteier.

INDIANA.[1]

Fifty-five selections were sent to the Indiana experiment station for testing in 1909. As the quantity of seed sent was small, they were grown in short rows that year, and no record was taken of the yields obtained. The following year all were grown in plats of one one-hundred-and-thirty-second of an acre each. Because of lack of space 20 strains were discarded after the 1910 harvest and 14 more after the 1911 harvest. The 1911 and 1912 tests were made in plats of one-twentieth of an acre each. The highest average yield for the three years, 54.4 bushels to the acre, was produced by selection 34a1–11–2–1 from the hybrid Burt × Sixty-Day. This selection also produced the heaviest yield of straw. None of the other selections from this hybrid were high in yield. Selections 49a2–12, Sixty-Day × Clydesdale, and 50a1–20–7, Sixty-Day × Probsteier, ranked next in yield, with averages of 51.8 and 50.5 bushels, respectively. The highest yielding selection of Sixty-Day was 62–II–19–1, with an average of 48.6 bushels. Of the strains tested, those just mentioned appear to be most promising.

KENTUCKY.[2]

A lot of 33 oat selections was sent to Prof. W. H. Scherffius at the Kentucky experiment station by Mr. Norton in 1907. The following year 56 selections were added. These were all grown in 1908 and 1909. After the 1909 harvest the number of selections was reduced to 49 by the elimination of those that were low in yield in the tests

[1] The tests at the Indiana station were conducted by Prof. A. T. Wiancko, to whom acknowledgments are due for the results here reported.

[2] The writer is indebted to Profs. W. H. Scherffius, George Roberts, and E. J. Kinney for the data presented from the Kentucky station.

made up to that time. This number was further reduced to 30 after the 1910 test. All the tests were made in 17-foot rows.

The highest average yields for the five years from 1908 to 1912, inclusive, have been produced by selections 34a1–19–4 and 34a1–13–3 from the hybrid Burt × Sixty-Day, 54.4 and 52.1 bushels, respectively. Other high-yielding selections are 138–5 (Early Champion), 48.3 bushels; 34a1–25–3 (Burt × Sixty-Day), 46.6 bushels; 62–II–6–3 (Sixty-Day), 45.8 bushels; 34a1–11–3 (Burt × Sixty-Day), 45.7 bushels; and 34a1–25–2 and 34a1–27–4 (Burt × Sixty-Day), 45.6 bushels. Of the selections grown for six years the highest average yields have been produced by selection 138–5 (Early Champion), 46.3 bushels; 62–II–6–3 (Sixty-Day), 43.2 bushels; and 34a1–24 (Burt × Sixty-Day), 40.8 bushels.

In 1912 the six selections which produced the highest yields for the three years from 1908 to 1910 were grown in twentieth-acre plats in comparison with ordinary unselected Burt oats. The yields of these selections were as follows: 34a1–11–3, 60.6 bushels to the acre; 34a1–13–3, 56.6 bushels; 138–5, 55.4 bushels; 34a1–12–1, 54.1 bushels; 34a1–19–4, 53.4 bushels; 34a1–24, 53.1 bushels; and Burt, 44 bushels. From the yields obtained in these tests and in the nursery, it seems probable that some of the selections from the hybrid Burt × Sixty-Day and from the commercial varieties Early Champion and Sixty-Day will prove of value in Kentucky.

TENNESSEE.[1]

Samples of seed of 112 selections were sent to the Tennessee experiment station in the spring of 1908. This lot was largely composed of selections from series 8 (Danish Island × Asia Minor Rustproof), series 33 (Burt × Burt), series 34 (Burt × Sixty-Day), and series 42 (Asia Minor Rustproof × Clydesdale). In 1908 these selections produced fairly good yields, but the following year and each year thereafter the spring-oat crop at the Tennessee station has either been destroyed by storms or so badly damaged as the result of them that no yields have been reported. Under date of October 19, 1912, Prof. C. A. Mooers writes:

> We have had a rather unfortunate outcome to our trials of spring-oat selections. The last three years they have almost invariably been blown down and badly lodged before reaching maturity, which, of course, causes them to fill out poorly. We continued to discard those which were least promising, and this year we planted only the following, which seem to be closely related:
>
> 31a1–16–1–5.
> 34a1–11–1.
> 34a1–11–2–1.
> 34a1–11–2–3.
> 34a1–11–2–4.
> 34a1–11–2–5.
> 34a1–11–2–6.
> 34a1–13–5.

[1] The tests at the Tennessee station were made by Prof. C. A. Mooers, to whom acknowledgments are due for the results here reported.

MINNESOTA.[1]

In the spring of 1908 fifty-three of the oat selections were sent to the Minnesota experiment station. These were tested in centgener beds from 1908 to 1911, inclusive. In the 1912 test the number of selections was reduced to 26 by the elimination of those that had made the least favorable showing in previous tests. The highest average yield per plant, perhaps the best indicator of the value of a strain grown in centgener tests, was obtained from selection 49a2–12 from the hybrid Sixty-Day × Clydesdale. The average yield per plant for this selection for the five years was 271.4 grams. Other selections from this hybrid which exceeded 250 grams in yield were 49a1–25–4 and 49a2–14–3. The only other selections which averaged as much as 250 grams of grain per plant were selections 50a1–3, 50a1–21, and 50a1–24 from the hybrid Sixty-Day × Probsteier. Some of the selections from the commercial variety Sixty-Day also yielded well.

SUMMARY.

The preliminary work in oat breeding was done at the Arlington Experimental Farm in Virginia and at McLean, Ill. A considerable number of hybrids were made in 1902, and numerous selections have been made from these and from commercial varieties in succeeding years.

The tests of these selections at McLean, which were continued until 1908, indicated the superiority of the Sixty-Day and Burt varieties and of hybrids between these varieties as material from which to select for central Illinois conditions. The selections from the hybrid Danish Island × Asia Minor Rustproof also produced high yields.

Sixty-four oat selections were tested at the Iowa experiment station for the six years from 1907 to 1912, and 381 selections for the four years from 1909 to 1912. These tests were made in duplicate in rows 15 feet long and 1 foot apart. The highest yields in the 6-year test were obtained from selections from the Welcome and Sixty-Day varieties and from the hybrid Sixty-Day × Probsteier. The highest yields in the 4-year test were obtained from selections from the hybrids Danish Island × Asia Minor Rustproof and Burt × Sixty-Day. The highest average yields for the various series of selections from hybrids and commercial varieties were obtained from the hybrids Golden Giant × Asia Minor Rustproof, Danish Island × Asia Minor Rustproof, and Burt × Sixty-Day, and from the commercial varieties Burt, Welcome, Silvermine, and Sixty-Day.

One hundred and forty-eight selections from hybrids and commercial varieties of oats have been tested in nursery rows at the Cornell University experiment station for one to six years. With the excep-

[1] The tests at the Minnesota station were made under the direction of Prof. A. Boss, to whom acknowledgments are due for the results here reported.

tion of one year, when the selections were grown on a gravelly loam soil, the tests have been conducted on a fairly fertile Dunkirk clay loam. The highest yields for the six years were obtained from selections from hybrids of Sixty-Day × Burt and Sixty-Day × Probsteier and from the commercial varieties Welcome and Silvermine. In general, the early-maturing strains produced larger yields than the medium or late maturing ones. The yields of selections from hybrids slightly exceeded the yields of selections from commercial varieties, but the difference is practically negligible. Eight selections produced an average yield 8.4 bushels to the acre higher than that of eight unselected commercial varieties in a 3-year test. The highest average yields, 65.1 and 65 bushels, were produced by the commercial variety Lincoln and the pure-line selection 123–5 from the Welcome variety, respectively.

None of the selections tested at the Pennsylvania experiment station appeared to be superior to the better commercial varieties. The best yielding selections were those from the Sixty-Day variety and from the hybrids Sixty-Day × Clydesdale and Burt × Sixty-Day.

At the Arlington Experimental Farm, selections from the Sixty-Day variety and from the hybrids Sixty-Day × Clydesdale and Burt × Sixty-Day have produced the highest yields.

At the Virginia experiment station, the highest yields have been obtained from selections from the Sixty-Day and Silvermine varieties and from the hybrid Burt × Sixty-Day.

Selections from the hybrids Sixty-Day × Probsteier, Danish Island × Asia Minor Rustproof, Burt × Sixty-Day, and Sixty-Day × Clydesdale have produced the largest yields at the Ohio experiment station. These yields have been slightly exceeded, however, by those of certain selections made at the Ohio station from commercial varieties.

The selections tested at the Indiana experiment station do not appear to be superior to the better commercial varieties which are grown there. The best yielding selection was one from the hybrid Burt × Sixty-Day.

At the Kentucky experiment station, selections from the commercial varieties Sixty-Day and Early Champion and from the hybrid Burt × Sixty-Day appear to be much better than unselected Burt or other commercial varieties which have been tested.

The tests at the Tennessee and Minnesota experiment stations do not supply sufficient data on which to base conclusions.

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